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DEVICE FOR DETECTING THE MANNER IN WHICH A VEHICLE SEAT IS OCCUPIED

Field Of The Invention

The present invention relates to a device for detecting the manner in which a vehicle seat is occupied, a stereoscopic image recording device having at least one optical sensor recording the scene at the vehicle seat, and deriving from that a three-dimensional map partitioned into a plurality of zones, giving, for each zone, the distance from a reference point.

Background Information

Investigations, e.g. by NHTBA (National Highway Traffic Safety Administration) have shown that children, sitting in the passenger seat of the vehicle, in particular in a backward aligned child's seat, have suffered deadly injuries from the realease of an airbag. A releasing airbag, in general, poses a danger of injury to a person in the vehicle seat, when this person, for reasons of sitting position, body size or leaning forward in the direction of the airbag prior to the occurrence of the accident, is at too short a distance from the airbag. There are occupational situations, especially in the case of the passenger seat, in which the airbag should better not be released. Among such occupational situations belongs, for example, the occupation of the vehicle seat by a child's seat, or laying down articles not needing protection, or a much too small clearance between the passenger and the airbag. Intelligent airbag systems for use in the future should be in a position to match the amount of airbag inflation to the size and the sitting position of the current vehicle occupant.

That certainly shows that it is unavoidable, for the control of the airbag's release, to detect the manner of occupation of the vehicle seat, in order to avoid unnecessary release of the

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airbag, or endangering the person in the vehicle seat. There already are different kinds of devices for recognizing the manner of occupation of the seat. A device for detecting the manner of occupation of a vehicle seat, described in the introduction, which has a stereoscopic image recording system, is described in German Patent No. 197 41 393. With the use of such a stereoscopic image recording device, distances of the vehicle seat area, divided by zones, form a reference point which can be ascertained with the aid of the known triangulation method. A so-called three-dimensional map containing a plurality of zones is generated thereby, from which can be read with great accuracy whether and how the vehicle seat is occupied, or which sitting position a vehicle passenger sitting on it has assumed for the moment. This information can now be used for controlling restraint systems such as airbags or belt tighteners.

The accuracy of a three-dimensional map created by a image recording device depends strongly on the image-taking quality of the optical sensors. The scenic lighting conditions have a strong influence on the image quality. In motor vehicles, especially, very extreme lighting conditions come about. This is true for one, because the motor vehicle is in an open environment. That means that the most varied lighting conditions are possible - day, night, low-in-the-sky and blinding sun, blinding headlights of other vehicles, etc. Besides that, a vehicle can move very fast, so that lighting conditions can change a great deal in a short space of time (e.g. while driving into a shaded region, while leaving a tunnel and the like. Linear optical sensors, as are used for the recognition of seat occupation according to German Patent No. 197 41 393, show a very great dependence on changes in brightness of the recorded scene. In order to reduce as far as possible the great brightness dynamics occurring in the vehicle, a strong light source for lighting the scene being looked at is required, according to German Patent No. 197 41

393.

The present invention now is based on the object of presenting a device, of the kind mentioned at the beginning, which, in spite of the great brightness dynamic, and even without using a very strong light source, can reliably identify the kind of occupation of a vehicle seat.

Summary Of The Invention

The object mentioned is attained, in that the at least one optical sensor, which is contained in the stereoscopic image recording device, has a nonlinear transformer characteristic describing the correlation between the entering light intensity and its electrical output, whose characteristic curve steepness decreases with increasing light intensity. Such a nonlinear optical sensor is capable of recording the scene at the vehicle seat with high resolution, even during great brightness dynamics, only a low-cost light source being required for illuminating the scene.

Optical sensors whose transducer characteristics have a logarithmic pattern are particularly suitable for recording scenes with very great brightness dynamics.

For the realization of a stereoscopic image recording device, either optical sensors arranged at defined distances from one another can be provided, or a stereooptical instrument, which images two images of the vehicle seat, offset to each other by a defined amount, on a single optical sensor.

Preferably, a light source is available for illuminating the scene of the vehicle seat, which shines synchronously with the activation of the image recording device. It is expedient if the light source shines a light in the infrared region, invisible to the vehicle passengers. In order to keep disturbing scattered light away from the image recording

device, an infrared band-pass filter is preferably arranged immediately in front of the at least one optical sensor, whose range lies within the light-sensitive range of the optical sensor.

Brief Description Of The Drawing

Figure 1 shows a vehicle with a stereoscopic image recording device.

Figure 2 shows a stereoscopic image recording device having two optical sensors.

Figure 3 shows a stereoscopic image recording device having one optical sensor.

Figure 4 shows a nonlinear transducer characteristic curve of an optical sensor.

Figure 5a shows a three-dimensional map of an unoccupied vehicle seat.

Figure 5b shows a three-dimensional map of an occupied vehicle seat.

Detailed Description

Figure 1 shows schematically a vehicle 1 having a vehicle seat 2, for example, a passenger seat. In the area of vehicle 1's roof, a stereoscopic image recording device is positioned, containing two optical sensors 3 and 4, by which the scene at vehicle seat 2 is recorded. The two optical sensors 3 and 4 record two image segments, offset by a defined distance from each other, indicated in the drawing by broken borderlines. The two image segments form an overlapping area 5 (the hatched area) which exactly encompasses the space of the vehicle seat in which a person or another object can stay. As can be seen in German Patent No. 197 41 393, with such a stereoscopic

image recording device one can ascertain the distance of image segments from a reference point (e.g. the location of the optical sensors or the location of the airbag cover), with the aid of known triangulation methods.

The stereoscopic image recording device illustrated in Figure 2, as shown also in Figure 1, includes two optical sensors 3 and 4, arranged at a defined distance from each other. Lenses 6 and 7 are arranged in front of the optical snesors 3 and 4, so as to form suitable rays. The output signals of the two optical sensors 3 and 4 are conducted to an image processor 8, which derives a three-dimensional map of the vehicle seat from the images recorded, as will be explained in more detail in connection with Figures 5a and 5b, and communicates the seat occupation ascertained from this, via an output signal 9, to a control device, not shown, for restraint devices. The control device can then control the release of one or more airbags and belt tighteners, depending on the information 9.

A light source 10 is provided to illuminate the scene at the vehicle seat. The light source 10 has, for example, a plurality of light diodes 11 emitting infrared light. The image processor 8 switches on the light source 10 synchronously with the image sensors 3 and 4. Thus, the light source 10 is only active when the optical sensors 3 and 4 are switched on for taking an image. In that way, the average emitted optical power can be held to as low as possible, at recording time the scene being illuminated with sufficient brightness. Recording of spurious radiation by optical sensors 3 and 4 can be avoided by placing an infrared band-pass filter, adjusted to the spectral range emitted by the light source 10, in front of sensors 3 and 4.

As shown in Figure 3, in place of two optical sensors, one single optical sensor 13 can be put in place, on which, via a stereooptical instrument 2, images are imaged which are offset

to each other by a defined amount. The stereooptical instrument has two optical ray paths, having rerouting elements 15, 16 and 17 arranged within them, lenses 18 and 19 being arranged at the input to the stereooptical instrument. The rays taken up by the optical paths, offset to each other, of the stereooptical instrument, strike adjoining, separate sensor zones in the optical sensor 13. That means, a sensor here records two images, which are evaluated in the image processor 8 exactly the same as in the exemplary embodiment according to Figure 2.

The optical sensors 3, 4, 13 have a transducer characteristic curve shown in Figure 4, which describes the correlation between incident light intensity L and the electrical output signal (voltage U or current I). The transducer characteristic curve has a nonlinear shape such that the characteristic curve steepness decreases with increasing light intensity. An optical sensor with such a nonlinear characteristic curve is known from German Patent No. 42 09 536. Because of the nonlinear shape of the transducer characteristic curve, the optical sensors 3, 4, 13 convert light signals with great brightness dynamics into a reduced output signal dynamic. Because of that, the contrast of the optical sensors 3, 4, 13 becomes constant, almost independently of the illumination intensity. In the case of such optical sensors, which have a nonlinear, preferably logarithmic transducer characteristic curve, high resolution recording of the scene at the vehicle seat is possible, even at great light intensity fluctuations.

In the upper part of Figure 5a an image segment 20 of vehicle seat 2 is shown, taken by the image recording device. Below that, a three-dimensional map 21, derived by image processor 8 from the two recorded images, is shown. On this map 21, the entire image segment is partitioned into a plurality of zones. The zones are assigned numbers which give the distance of the respective image zone from a reference point. The larger the

numerical value, the greater is the distance of the respective image zone from the reference point. Zone 22, for example, has a distance value of 76. Some zones are not furnished with a number because the image processor was not able to ascertain an unequivocal distance value for them.

The upper part of Figure 5b shows an image segment 23 of the vehicle seat 2 occupied by a person 24. Below that is the three-dimensional map 25 ascertained by image processor 8. A comparison of the three-dimensional map 21 of the unoccupied vehicle seat with the three-dimensional map 25 of the occupied vehicle seat makes it clear that, using the described image recording device, unequivocal information about the sitting position of a person occupying the vehicle seat can be obtained. The three-dimensional map also gives unequivocal information on whether the seat is occupied in the first place, whether there is a child's seat on it, whether there is a small or a large person on the vehicle seat, or whether the vehicle seat is not occupied at all by a child's seat or a person, but rather, another article has been put down on it.